



Nondestructive Evaluation Using Fiber Gratings for “Strain Imaging”

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Report Documentation Page

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14. ABSTRACT Arrays of multi-axis fiber grating sensors have been embedded into composite demonstration articles and used to support the identification and localization of both cut tow and Teflon tape defects. This presentation will overview the characteristics and performance of multi-axis fiber grating strain sensors to perform strain imaging and comparisons will be made to ultrasonic and eddy current techniques. Issues that will be addressed will include the distance over which damage may be detected via "strain imaging," "strain imaging" through successive composite layers, and "strain imaging" through optical fibers. Strain images from cut tow and Teflon tape defects are distinctly different. The embedded multi-axis fiber grating strain sensors may be used to monitor both global strain characteristics such as deformation of the cylindrical composite demonstration article under pressure as well as local damage events that may be impacts. This paper will report progress on multi-axis fiber grating strain imaging systems and future plans.				
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Strain Imaging

- Localization and identification of damage through detailed measurement of strain fields
- Information provided in seconds on demand with target accuracies comparable to ultrasound or eddy current
- Enabling technologies, multi-axis fiber grating strain sensors, improved spectral detection methods, processing algorithms

Strain Imaging Demonstration

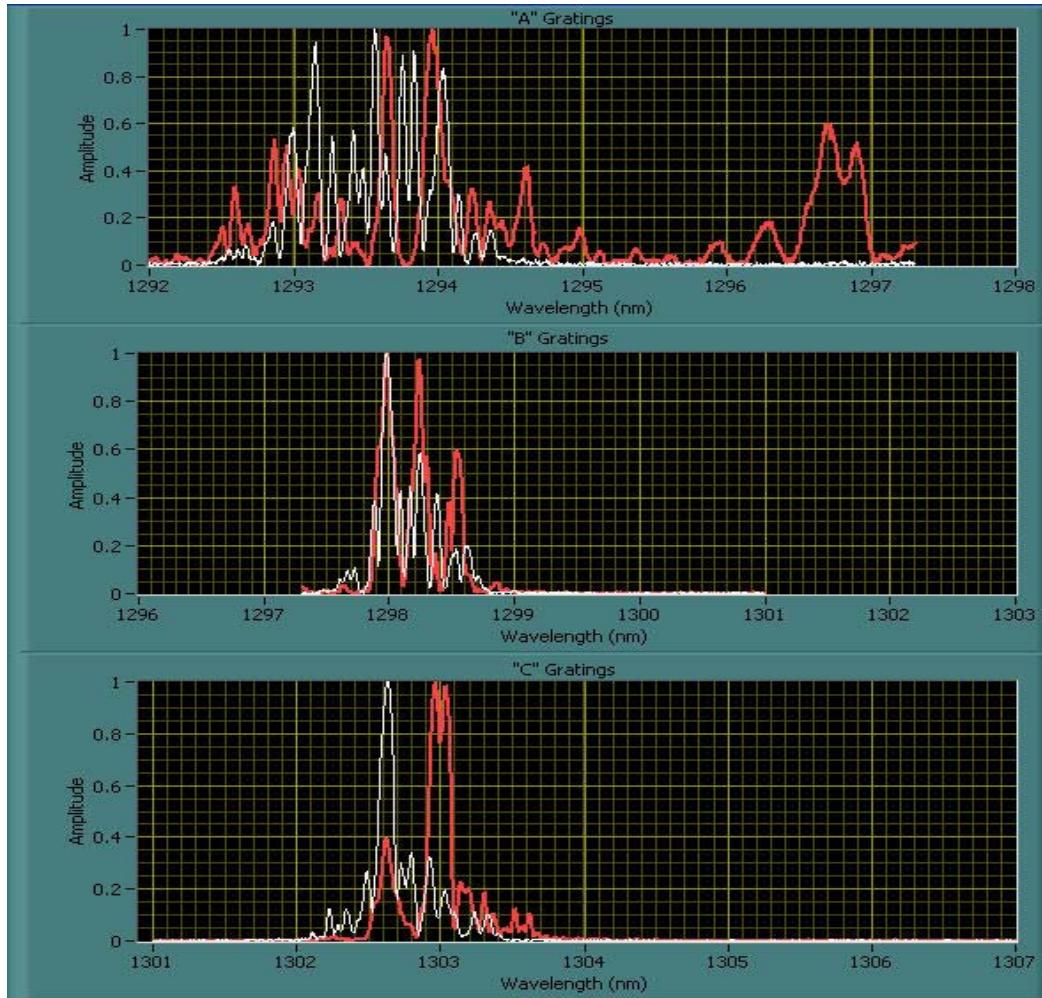
- Composite rocket motor filled with inert propellant
- Impacts at 5, 10, 15, and 20 ft-lbs energy
- Fiber arrays in region of damage read out with Blue Road Research Strain Imaging system and damage location plots shown

Strain Imaging Bottle Impact Test



Strain Imaging Bottle Impact Test

Grating Spectra Before Impact



Strain Imaging Bottle Impact Test

Before Impact



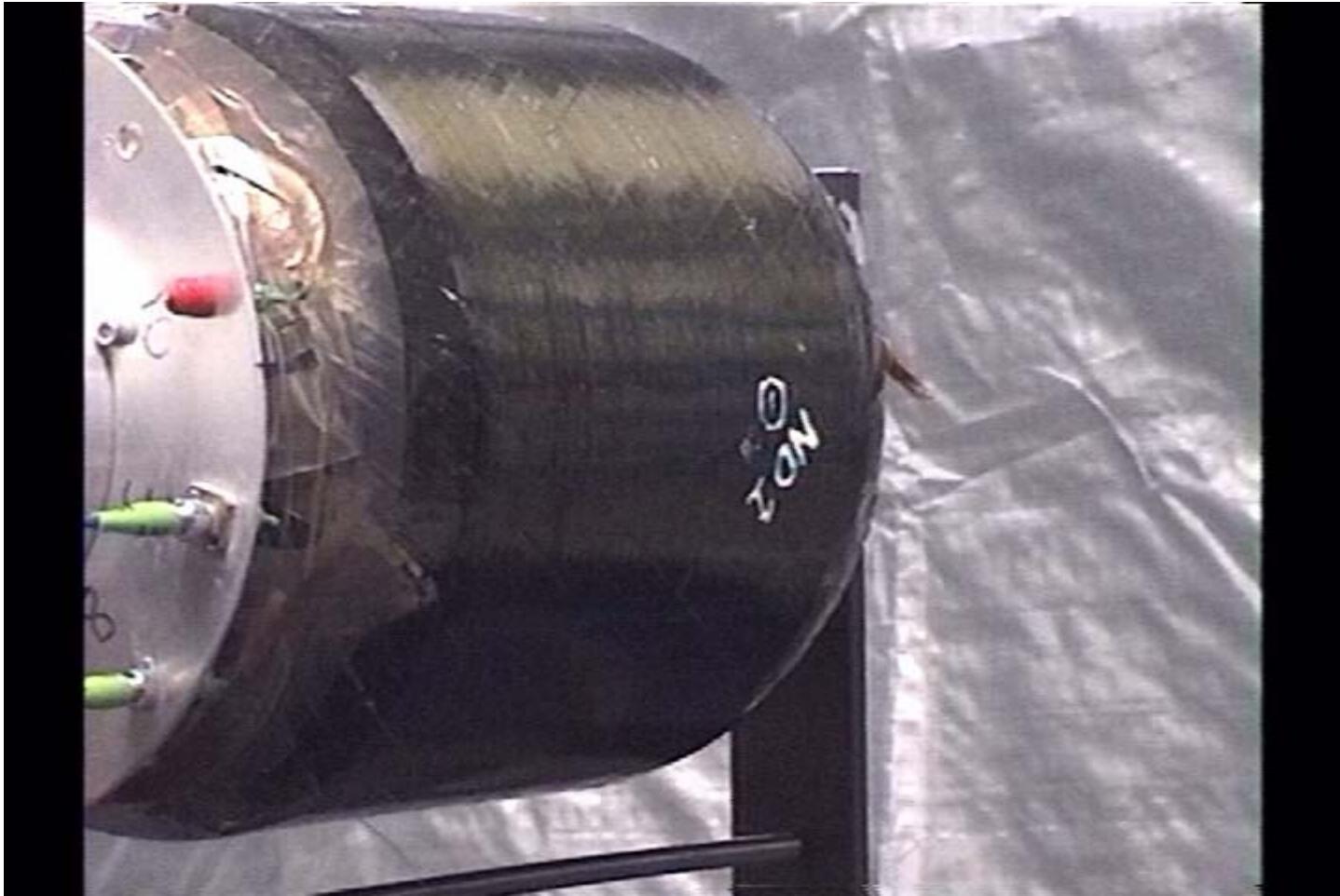
Strain Imaging Bottle Impact Test

5 ft-lb Impact

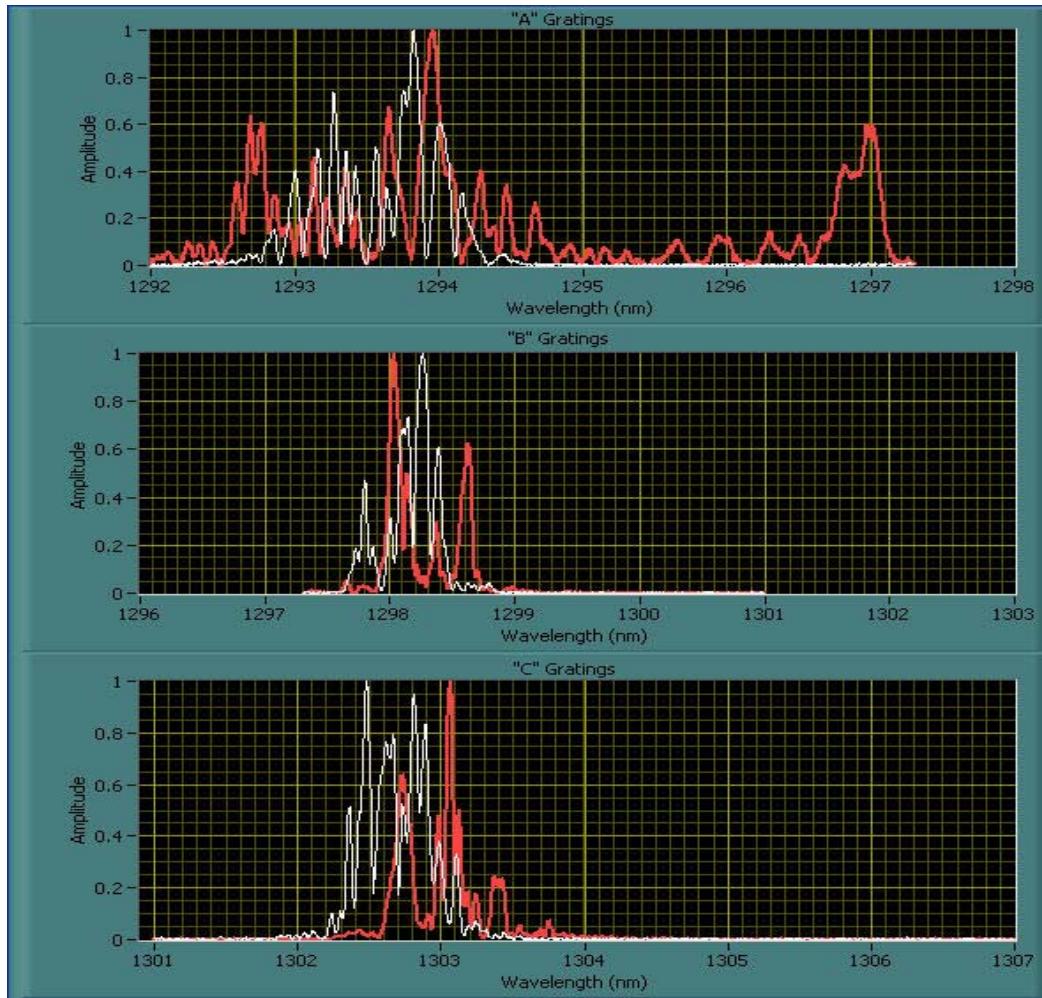


Strain Imaging Bottle Impact Test

5 ft-lb Impact



Strain Imaging Bottle Impact Test Grating Spectra After 5 ft-lb Impact



Strain Imaging Bottle Impact Test

After 5 ft-lb Impact



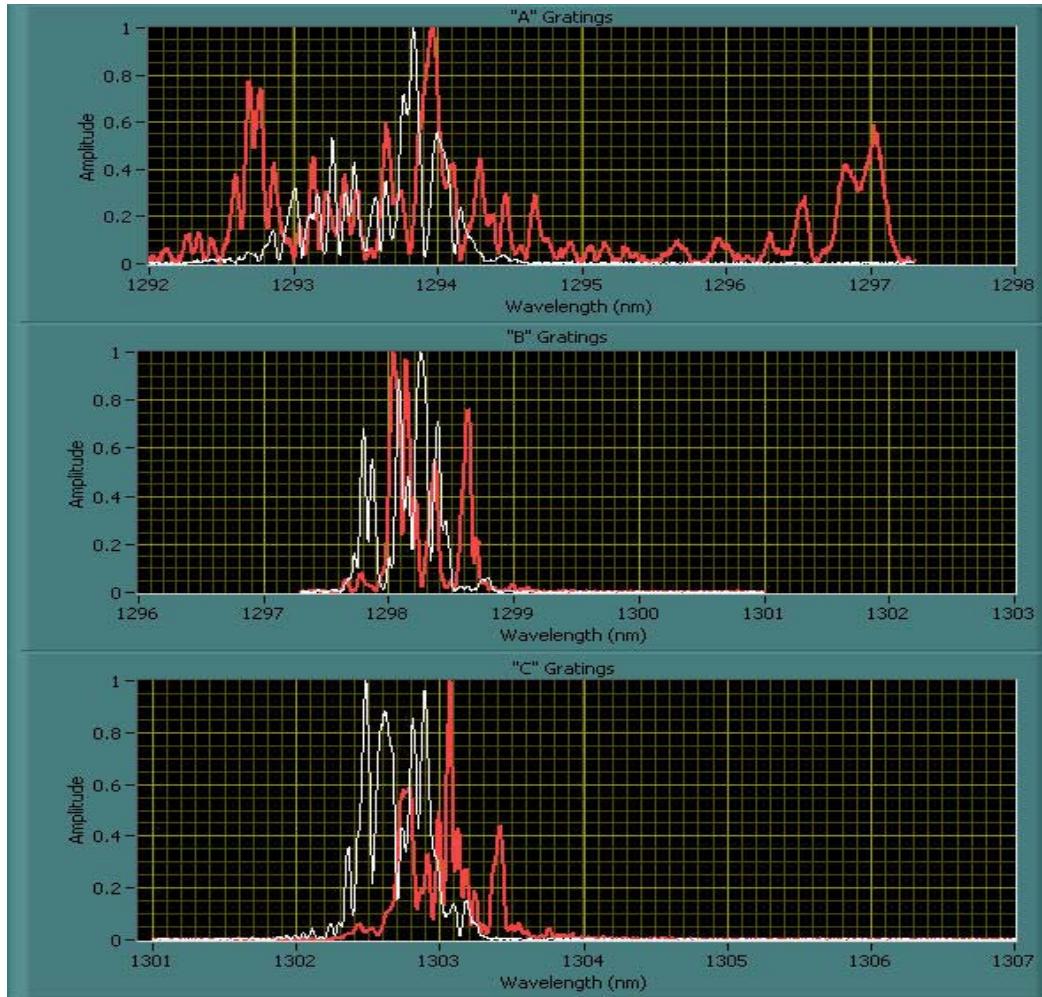
Strain Imaging Bottle Impact Test

10 ft-lb Impact



Strain Imaging Bottle Impact Test

Grating Spectra After 10 ft-lb Impact



Strain Imaging Bottle Impact Test After 10 ft-lb Impact



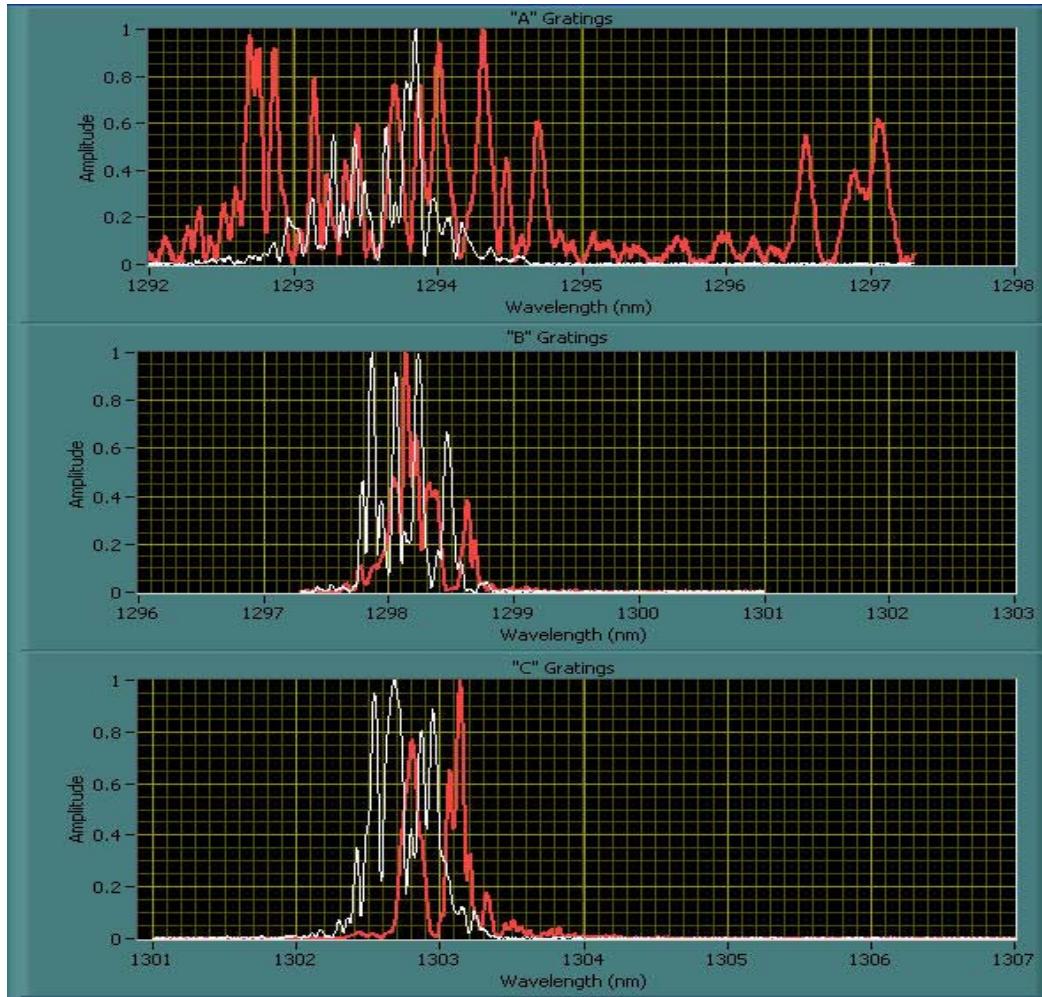
Strain Imaging Bottle Impact Test

15 ft-lb Impact



Strain Imaging Bottle Impact Test

Grating Spectra After 15 ft-lb Impact

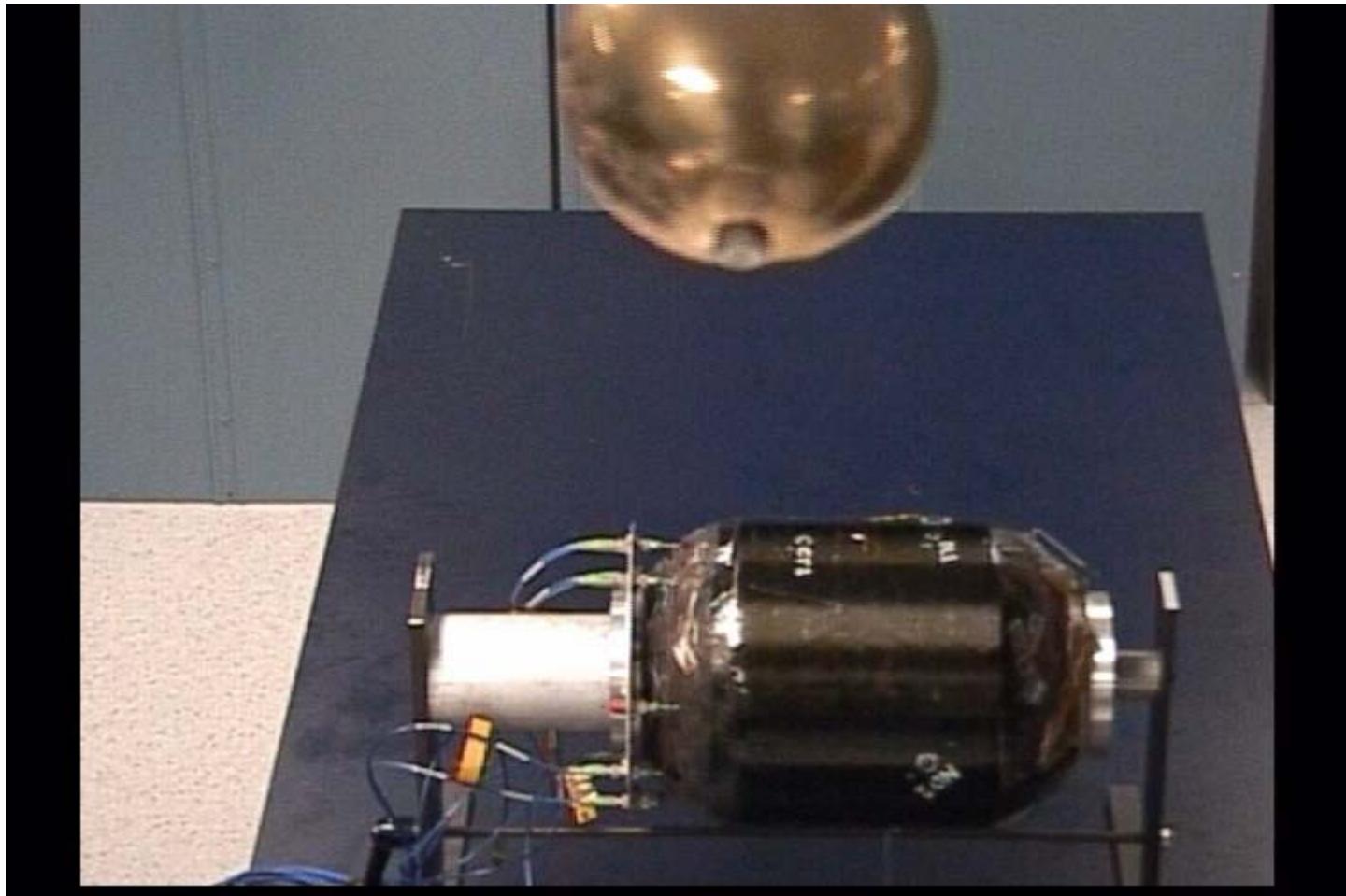


Strain Imaging Bottle Impact Test After 15 ft-lb Impact



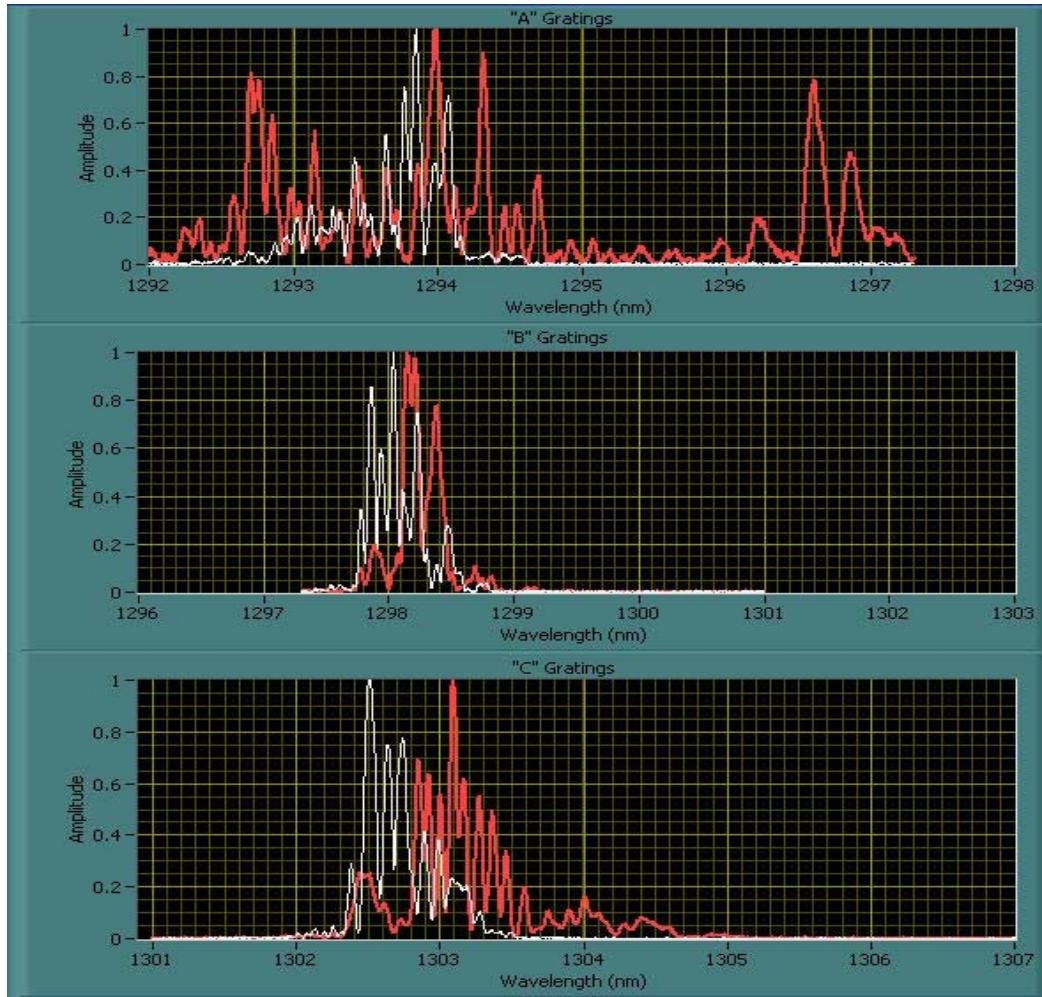
Strain Imaging Bottle Impact Test

20 ft-lb Impact



Strain Imaging Bottle Impact Test

Grating Spectra After 20 ft-lb Impact

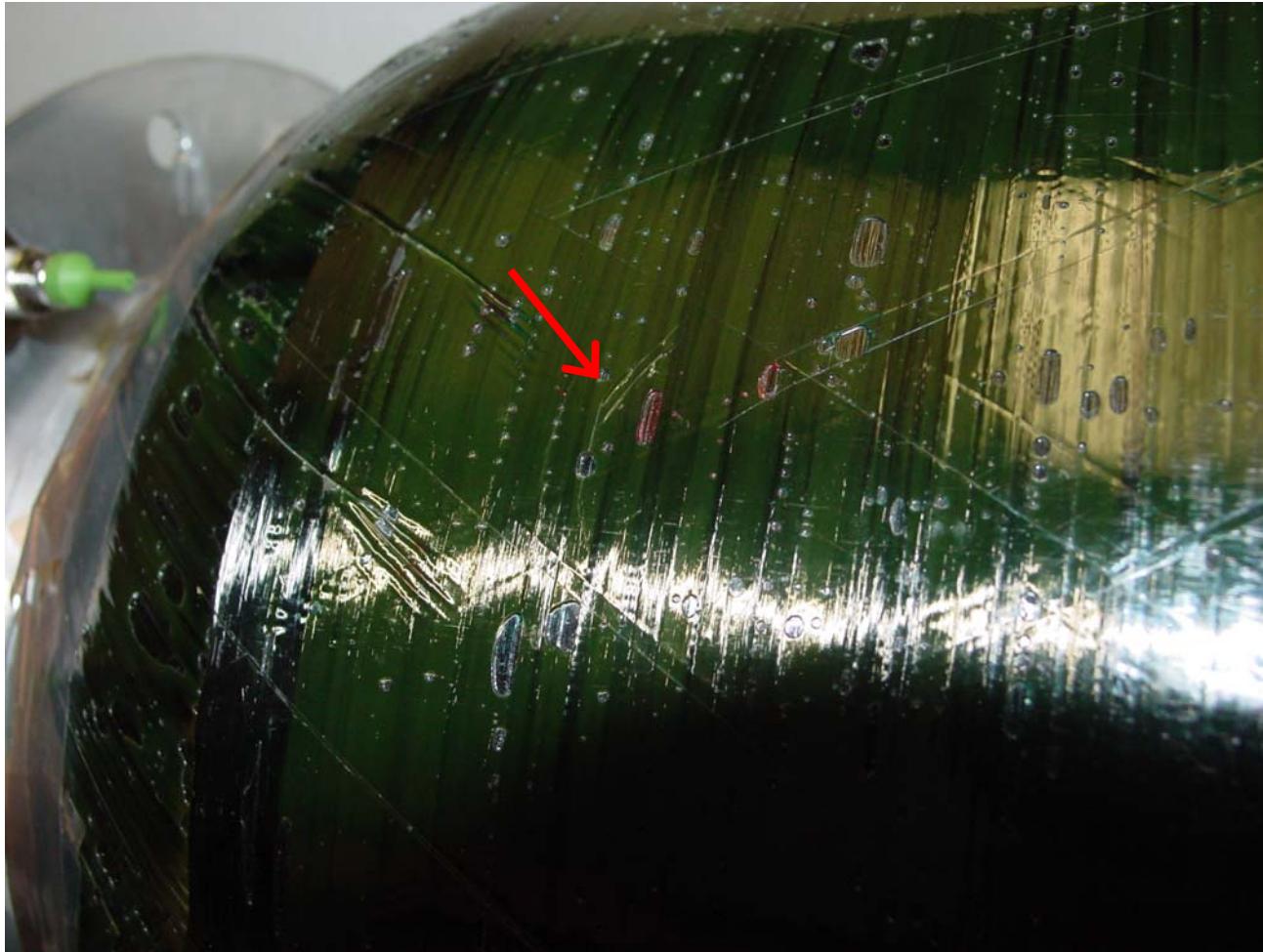


Strain Imaging Bottle Impact Test After 20 ft-lb Impact



Strain Imaging Bottle Impact Test

Damage Area After All Impacts



Strain Imaging Bottle Impact Test

Damage Area After All Impacts



Summary

- Multi-axis fiber grating sensors successfully used to perform “strain imaging” to locate damage
- Multiple impact levels visible
- Damage detected with “strain imaging” that could be missed via physical inspection